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IMMUNOLOGICAL PROPHECY FROM ANCIENT HIEROGLYPHICS[1]

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OUR first half-century of modern immunology has been characterized by recurring waves of clinical hope and clinical disappointment. A hundred theoretically logical, monovalent, polyvalent, prophylactic and curative antisera proposed, clinically tested and commercially exploited during the transitional years of the twentieth century. Ninety-five per cent. of them thrown into the clinical discard. An equal number of theoretically logical, monovalent, polyvalent, prophylactic and therapeutic vaccines. A scant 5 per cent. of them of more than historic interest. A thousand frantic clinical trials with theoretically logical opsonic index and leucocytic extract. All shelved with the miasmas and phlebotomies of our Revolutionary ancestors.

And we call this scientific medicine.

This overwhelming clinical disappointment has served one useful purpose. It has graphically dramatized the errors and inadequacies of the immunological theories from which the proposed clinical methods were logical and consistent deductions. No immunological hypothesis of the past half-century has had a clinical verification probability of more than 5 per cent.

The pressing need of clinical medicine at the present time is a radically new immunological theory, basic hypotheses more nearly consistent with clinically verifiable fact. I have thought that we might possibly obtain hints as to the probable nature of such a theory from the discarded immunological "hunches" of primitive medicine, jungle hypotheses jettisoned by the shifting theologies of medieval civilization.

[1] Read before the Pasteur Society of Central California, San Francisco, California, May 1, 1929, and before the American Association for the Study of Allergy, Portland, Oregon, July, 1929.

A clinician whose collateral reading leads him into the field of primitive anthropology and comparative religion will be surprised to find that theoretical immunology, which he has previously considered the newest branch of scientific medicine, is in reality the oldest clinical science. The medicine-men of the Congo and the jungle doctors of the Orinoco have to-day an immunological theory that is more detailed and of wider clinical application than the boasted immuno-science of Nordic medicine. There is not a fundamental deduction from present-day infectious theory that was not known, predicted or parodied by the predynastic Osler's of ancient Egypt, fifty centuries before the nineteenth century renaissance of the same deductions.

I

In dealing with the basic hypotheses of jungle clinicians we are not dealing with primitive religion. In spite of the theological nomenclature in which so much of primitive anthropology is recorded, the pathological theory of the jungle clinic is not theology, but a material science—a pseudoscience, if you will—a nearer approach to the material science of the twentieth century than were any of the natural philosophies of European civilization down to and through the Elizabethan era.

This primitive pseudoscience is graphically illustrated by the Stone Age theory of water evaporation. To the jungle biochemist water is liquefied human soul, a soul fully conscious of its environment by a method of sense perception which jungle physiology fully explains. This liquid life is endowed with an intelligence equal to that of the legendary human ancestor from which it was originally condensed, with the retained memories, ambitions, likes, dislikes, instincts and tribal affiliations of that ancestor. At will this liquid personality may flow in any direction, may dance as waves, sleep in the form of ice, or fly away as mist or as invisible water vapor. A million individual Waters—oceans, lakes, streams and urines—broadcasting their hopes, fears, needs and ambitions through the great intangible over-personality, General Humidity.

Organized, directed and coordinated through this unseen, all-embracing Aqueous Intelligence, individual Waters may mobilize from the far horizon for offensive or defensive warfare. Falling in fruitful marriage with the soil, a desquamated fragment of General Humidity may be reborn or metamorphosed into one of the dual or triple subsouls of growing plants. Taken into the human stomach, an individual Water is ceremoniously baptized with gastric juice, formally adopted into harmonious communion with the human tissues, fused with or metamorphosed into a subunit of the human soul, thus raising man to the dignity of full material brotherhood with General Humidity.

II

Apply this evaporation theory to all animals, plants and inanimate objects—each a material personality, that at will can change from a solid to a liquid, to a visible mist or to a wholly invisible gas. Picture human blood, gastric juice, saliva and perspiration as liquefied or melted Human Body. Surround and permeate the tangible body with an activating, directing, coordinating Human Gas. Handicap this gaseous colloid with a constant surface evaporation by which its material substance is slowly but inevitably lost to the environment. Motivate this colloidal gas with a compelling hunger for other solid, liquid and gaseous substances; its only compensation for surface loss. And you have the basic concept of jungle physiology.

Fill the environment with competitive, mutually carnivorous solids, liquids and gases. Aerial, aquatic, terrestrial and subterranean, visible and invisible, alert or dormant competitors. Tangible and intangible herbivorae, carnivorae and omnivorae. Weak, strong, brave, cowardly, loyal or disloyal, seen and unseen, friendly or unfriendly personalities. Organized visible and invisible bandits, formal declarations of war, surprise attacks, armistices and treaties of peace. The basic concept of jungle epidemiology.

Oppose this snarling world of visible and invisible hungers with man's own solid, liquid and gaseous transubstantiation resistance. Or with the organized colony of three, four, five, seven or more subsouls or subresistances with which the primitive human body is usually endowed. Subsouls sleeping in bones, finger-nails, teeth, hair and skin. Alert semi-liquid subpersonalities in muscles and internal organs. Wide-awake subentities actively patrolling the body as blood, gastric juice, urine, saliva and perspiration. Still more active invisible symbions hurling themselves in an aggressive respiratory tide against an ever-threatening environment. Advance gaseous scouts in body odors and visual emanations. The basic concept of jungle immunology.

With threatened visible or invisible invasion, consubstantiation or transubstantiation see how each loyal subpersonality springs to battle. The ever-ready stomach melts to a potent ghosticidal, gastric juice, narcotizing, paralyzing, enveloping and sweeping from the body visible and invisible nutritional pathogenicities. No wonder the gastric contents of friendly, loyal, ceremoniously adopted, domestic herbivorae are such powerful antitoxic agents to primitive science. Logical surgical dressings. Dependable internal salvarsans. Sacramental wafers of later religions.

See how the faithful, ever-alert, ghostolytic blood rushes to an area of local irritation. The primitive theory of inflammation. With what heroic self-sacrifice it spurts defiance against wound pathogenicities. See the semi-dormant flesh awake, melt to specially trained ghost-fighting pus, or to keenly alert antitoxic serous exudate.

And remember this is not poetry, but serious science, on which primitive man daily stakes his life.

III

Childish as such concepts seem to modern biology, they gave our jungle ancestors many logical deductions that modern medicine has resurrected and endorsed. Centuries before Fracastoro, for example, jungle physicians concluded that direct and indirect physical contacts are the main methods of disease transmission. Every instrument of jungle surgery is ceremoniously sterilized. Tobacco tea, chicken blood, gastro-intestinal contents, urine, saliva, or other equally potent, equally logical, loyal, friendly, ceremoniously adopted, primitive carbolic acids.

Contaminated with the blood of his slain enemy, the returned warrior marches with silent lips and averted eyes past wives and children. One touch may transfer enemy pathogenicity. With tobacco fumigation, perspiration gymnastics, cathartics, formal baptism in wide-awake, friendly, ceremoniously adopted running water, and a final sprinkling with loyal ghostolytic chicken blood, he frees his body from every visible and invisible, solid, liquid and gaseous trace of his contaminating foe.

With illness or death, every member of a patient's family, his dog, parrot, wearing apparel, weapons and cooking utensils are automatically untouchable. Safely touched only by the attending physician, whose natural transubstantiation resistance has been strengthened by ceremonious venesection, formal fasting, ritualistic purges and sexual conservation. Tobacco smudges in the hut. Sprays of loyal antitoxic herbivorous blood. The essential technique of modern sanitation.

As our forefathers passed beyond the stage of personified materialism into the stage of pagan religion, with its conception of man's slavery and exploitation by giant, invisible, non-material Entities, this early contact theory of material infection became illogical. What material created by a kindly god, or animated by a minor devil, can produce disease in an individual vitalized by omnipresent, semi-omnipotent, omni-antiseptic Osiris! Unless, of course, in just punishment for theological error, the individual has been abandoned to the ravages of demon-activated materials.

It is true, pagan religion continued to stone lepers from the city gate. But this was not to avoid physical contact. A slap on the leper's face would not transmit leprosy. A kindly word to the sinful outcast might offend the Omniantiseptic, and thus induce the disease.

No wonder the suggested renaissance of the primitive contact theory of material infection during the early decades of the sixteenth century was heresy, logically followed by excommunication and burning at the stake. Even the thundered rhetoric of Oliver Wendell Holmes during the middle decades of the nineteenth century failed to convince American physicians of the logic of washing their hands between obstetrical deliveries or before surgical operations.

IV

Not all Stone Age medicine, however, was thus discarded. Many materialistic methods were endorsed by later paganisms—some even by still later Christianity. The Aztec drug, sarsaparilla, for example.

Centuries before Columbus, this subtropical bramble was developed by Mexican pseudoscience as a friendly, dependable, prophylactic and therapeutic plant soul. Its vigorous underground roots, a single plant often dominating a soil area sixty feet in diameter, amply proved to Aztec biologists that sarsaparilla is a materialized or condensed spirit, or gas, fully competent to penetrate, seek out, kill or repel alien ghosts from the remotest, most hidden parts of the human body. Its thorny aerial growth, smothering other plants, shunned by herbivorae, on which few birds nest and fewer insects feed, logically demonstrated its antiparasitic totemship. The red berries proclaimed its ability to gather redness or anti-anemia gas from the environment.

Adopted from Aztec pharmacy, sarsaparilla was endorsed by European clinicians as the particular bramble, woven into the crown of thorns, pressed on the Savior's brow, and thus eternally impregnated to the remotest representative of its species with the Satan-expelling blood of the medieval antiseptic Christ. Within a century sarsaparilla was raised to the dignity of the only dependable salvarsan for venereal sin, which proud position it held till the Victorian era.

V

The contact theory of material infection is but one of the primitive anticipations of modern bacteriology. Prophylactic and therapeutic vaccines, monovalent and polyvalent counter-inoculations, were among the commonest medicinal agents of our pre-pagan forefathers.

The technique of primitive vaccination, of course, does not always anticipate that of modern bacteriology. Inhaled gaseous vaccines, for example, have not yet been perfected by Nordic chemists. Nor are

visual, auditory, olfactory and telepathic vaccines within the range of immediate verification. But genito-urinary douche vaccines, spray vaccines for the nasal mucosa, immunizing pills and cutaneous massage with ceremoniously attenuated lipo-viruses may well be within the range of future interest.

Imagine an equatorial Indian whose chattering teeth proclaim infection with "mosquito gas." Tropical malaria, insect vectors, a thousand years before Theobald Smith. Fortified by fasting, sexual conservation, emesis, catharsis and a hilarious dose of loyal, fermented pre-Volstead antiseptic; protected by the volatilized gas from mosquitocidal bat-wings and insectivorous bird heads; preceded by an insect-narcotizing tobacco smudge; the air purified by the auditory vapors from insect-scaring tom-toms and bull-roarers, the tribal immunologist courageously approaches the patient. Grasping in his hand a whip made from some ceremoniously gathered, formally adopted, loyal, friendly, antiseptic wood, over which mosquitolytic wood no malarial gas can crawl or diffuse onto his own hand, he lashes the patient's bare back till blood gushes in streams. The physician now holds the dripping whip to the patient's lips. The patient swallows the autogenous blood. After an incubation period of from seven to fourteen days the patient is well.

Here the mosquito-impregnated autogenous blood is changed to an attenuated malarial vaccine by contact with the mosquitocidal whip.

It is interesting that this autogenous vaccine is not reintroduced through skin incisions, as is done with so many primitive vaccines. It is given orally, so that the partially licked mosquito gas may be brought into contact with tissues not yet injured, fatigued and discouraged by the infection. Such tissues will presumably dismember the attenuated malaria vapor and so terrorize the extra-gastric mosquito ghost that it will fly from the body.

More complex methods of virus attenuation are often practiced. Desiccation of enemy livers in prophylactic cannibalism, exposure of infected dung to sunshine, dilution of snake venom with tobacco tea, putrefaction, fermentation, neutralization with saliva, with animal blood, and even detotemization by animal passage. A living chicken, for example, plucked of its insect-resisting feathers, may be sprinkled with the autogenous malarial blood till the chicken tissues are saturated with mosquito gas. The pulsating chicken heart is now plucked out, and given to the patient to swallow. A true toxin-antitoxin mixture, the malarial gas being cowed, partially licked by its inward diffusion through insectivorous chicken tissues.

In further anticipation of William Park and Theobald Smith, the mosquito-impregnated chicken heart must be plucked from the insectivorous bird without delay, before the malarial gas is completely licked, adopted or metamorphosed into chicken flesh. An over-licked toxin-antitoxin mixture would afford no specific exercise to the gastro-intestinal tract.

Primitive immunology often obtains attenuated viruses by drawing vaccines from some part of the body whose local resistance is presumably sufficient to adequately lick the infection. In the prenuptial anti-venereal cross-vaccinations of Northern Africa, for example, attenuated groom semen and bride vaginal secretion are not always used. Certain Arab tribes use cross-baptism with fully virulent bride and groom urine. Or oral immunization with fully active bride and groom blood.

One of the earliest forecasts of modern anaphylaxis is contained in such ceremonials. The prenuptial anti-venereal cross-inoculation at first produces a specific venereal hypersusceptibility. This absolutely prevents the biological consummation of marriage till the end of the hypersensitive period, usually fourteen to thirty days. In certain Arab tribes the transient hypersensitiveness lasts seven weeks, exactly the same as the modern transient hypersensitiveness in canine anaphylaxis.

VI

In addition to etiologically specific vaccines, primitive medicine abounds in symptom-specific inoculations. According to early Egyptian pathology, for example, baldness is due to a local scalp infection with capilliphagic ghosts. In the presence of these hair-eating gases no hair dare show itself above the surface. A logical symptom-specific vaccine, therefore, was obtained from attenuated anti-hairiness potential of frog skin.

It was an essential in this symptom-specific scalp immunization, as it was in the nineteenth century renaissance of symptom-specific vaccines by Hahnemann, that the baldness-producing virus must be administered in minute, wholly non-toxic doses, doses which the fatigued and discouraged scalp can easily lick. Otherwise in place of an increased scalp-courage an increased hair-timidity or scalp-cowardice might result.

VII

In a few cases, primitive medicine actually anticipated modern vaccination technique. For example, the early Spanish explorers brought to America cattle, syphilis, smallpox and cow-pox. Syphilis and smallpox are known to-day as "Caucasian disease" by certain equatorial Indians. What more logical, therefore, than for Aztec hygienists to conclude that cow-pox is "Caucasian disease" attenuated, detotemized or partially adopted to Aztec loyalty by animal passage. Two centuries before Jenner, they found cow-pox inoculation a reliable preventive of smallpox.

Dilute snake venom or minute doses of scorpion extract introduced into ceremonious skin incisions, and poison ivy leaves chewed as an oral vaccine, are other Aztec anticipations of modern technique.

VIII

Primitive medicine also abounds in logical and consistent methods of passive immunization. Baptism with convalescent urine is still practiced in many primitive societies. Massage with convalescent dung, a routine method in ancient Egypt, the birthplace of the latest renaissance of primitive fecal therapy, under the modern jargon, "bacteriophage." Pills of convalescent pus. Convalescent semen, perspiration, hair, finger-nails. The fat of a ceremoniously killed, senility-resistant chief. The body of a new-born babe painted with the experienced blood of its father. The heroic tribal physician who bled himself to death that every member of his small tribe might drink of his ceremoniously strengthened blood.

Modern medicine has no monopoly on medical heroes.

IX

Such parodies of twentieth century logic are of slight interest to modern clinicians unless they suggest possibilities not yet adequately tested by potential Jenners. I believe they contain a dozen untested possibilities. From the crude ore of Stone Age prescriptions, ceremonials and taboos, I have, therefore, attempted to extract or reconstruct the basic hypotheses in my own narrow field of immunological interest.

According to the predynastic Pavlovs of ancient Egypt a protein molecule is a minute, living, spiritually independent, self-propagating, materialized, or condensed animal or plant soul. This pulsating molecular individual injected into human tissues carries with it the gender, ambitions and tribal friendships of the animal or plant from which it was obtained. Introduced into human tissues, this minute alien personality may be excommunicated by the molecular subsouls of its human host. Or it may be enslaved and trained to cooperative service with human molecules. Desirable aliens may be adopted into full colloidal brotherhood with the human body, married to native somatic proteins, and become the parents of half-caste, quarter-caste or eighth-caste molecular hybrids. Mongrel proteins. Bastard colloids. Semi-permanent symbions with the human body. Eventually even raised to the dignity of subcommand.

X

Translated into modern nomenclature, this conception assumes that a desirable foreign protein is gradually naturalized or hybridized with human tissues, or otherwise changed to an immunological specificity approaching that of the host. This is not as silly as it seems. Two intermediary denaturization stages are experimentally demonstrable.

Horse protein injected intravenously into normal dogs, for example. By the end of four days, this protein completely loses its power to call forth recognizable anaphylactic reactions on massive transfusion into hypersensitive dogs.[2] By the end of six days, it loses its power to stimulate the production of active sensitization in normal dogs.[3] Titrations by means of rabbit precipitin indicate that neither of these losses is due to a quantitative reduction of horse protein in the donor's blood.

By the end of thirty days a second denaturization stage is demonstrable. This is shown by a marked decrease in the intensity of the precipitin reaction in low dilutions, but with no reduction in horse protein titer as determined by high dilutions.[4] Additions of a small amount of fresh horse protein to the titrated samples give no indication that this zonal precipitin response is due to an inhibiting antibody.

The thirty-day precipitin reaction is exactly the one we would predict from an alien protein specificity midway between that of horse and dog. A true protein hybrid of ancient metaphor. If this is not actual semi-caninization of horse proteins, what is it?

XI

A second prediction from the hybridization metaphor is that the number of alien molecules may actually increase in the body of the new host, that is, that the alien protein has the same self-propagating potential as that currently assigned to the bacteriophage. Parallel precipitin titrations of dog blood at varying intervals after subcutaneous injection with horse protein give readings that suggest such multiplication. By the seventh day there is an apparent 100 per cent. absorption of the injected horse proteins into the blood stream, rising to an apparent 200 per cent. or even 400 per cent. absorption by the fourteenth to twenty-first day.

Such an apparent increase, of course, does not necessarily prove chemical multiplication. An apparent increase might conceivably result from proteolysis, provided it is possible for an alien protein to fragment into two or more daughter proteins of the same group-specificity. Such symmetrical proteolysis, however, has not yet been experimentally demonstrated.

An apparent increase might conceivably result from a specific alienization of body proteins—again a possibility no biochemist will admit, nor is pre-

[2] *Jour. Immunol.*, 1927, 13: 357.
[3] *Ibid.*, 1928, 15: 109.
[4] *J. A. M. A.*, 1928, 90: 2090.

pared to deny. Biochemical alienization of body proteins is, of course, well known. But the production of denaturization products of the same group-specificity as antigens has not been demonstrated.

The apparent increase, of course, is based on the assumption that the precipitin reaction is a reliable qualitative and quantitative index of protein specificity under the relatively complex conditions of our mixed serum tests. Till this is proved or disproved the apparent bacteriophage-like proliferation is but an interesting challenge to future biochemists.

XII

A third prediction from the hybridization metaphor is that mongrel proteins may become permanently symbiotic with the human body. A prolonged retention of alien proteins is rank heresy to modern physiology. Nevertheless, in our hands, rabbit precipitin titrations indicate a very nearly quantitative retention of hybridized horse proteins in the canine circulation for at least four months. If this is not symbiosis, what is it?

Such possible molecular symbiosis introduces the element of pure drama into the human body. Each man an organized colloidal society of ceremoniously adopted ancestral infections and partially digested dinners. The ancient Pavlovs did not make the mistake of assuming that foods always lose their specific alien totemism following formal baptism with gastric juice, any more than they assumed that captive enemies were always won to full, dependable, tribal loyalty by formal sprinkling with tribal blood.

XIII

The hybridization metaphor further suggests that, in addition to first-generation mongrels, there are second-generation, third-generation and even more remote hybrids, antibodies or protein denaturization stages. Such a suggestion is rank heresy against our current orthodox dogma, which pictures all circulating antibodies as desquamated specific chemical angels with which the fixed tissues of Adam were miraculously endowed.

That at least two chemically distinct antibodies are formed or liberated following injection with a single foreign protein is readily shown by transfusion tests. Fractional transfusion from a protein immune dog, for example, will not confer passive hypersensitiveness on a normal dog, as it would if the difference between the hypersensitive antibody and the immune antibody were purely quantitative.[5] Fractional transfusion from an immune dog will even desensitize hypersensitive canine tissues.[6] Fractional transfusion from a hypersensitive dog occasionally confers on a normal dog a higher degree of specific sensitization than that shown by the donor.

These are exactly the results one would predict from the assumption that the so-called anaphylactic antibody is a relatively unstable primary antibody chemically related to or derived from the foreign protein, while the so-called immune antibody is a relatively stable secondary hybrid of antagonistic or supplementary physiological function.

Even more convincing evidence of dual antibodies is furnished by protein-denaturizing rate. Representing the horse-protein-denaturization rate in normal dogs by one, the denaturization coefficient in hypersensitive dogs is 6 to 8.[7] In immune dogs there is the opposite of this, a denaturization inhibition, the rate being about 0.7.

XIV

Probably the most important clinical suggestion from the ancient hybridization metaphor is the doubt it would cast on the current assumption that each and every specific serum property demonstrable by test-tube reactions is an "antibody," that is, a specific defensive chemical substance. For two generations test-tube "antibodies" have been taken as presumptive evidence of clinical immunity, in spite of puzzling lack of parallelism between serum titer and clinical outcome. Test-tube "antibodies" have justified the commercial exploitation of a hundred alleged specific "antisera."

The hybridization metaphor would picture test-tube "antibodies" as retention products or symbiotic derivatives from injected antigens, with no suggestion as to their probable immunological function. Many retention products are presumably physiologically inert. Unstable products might conceivably play a hypersensitive rôle. A few products are conceivably protective.

A very opportune illustration of what the hybridization metaphor may do to clinical serology is contained in a recent paper by Kryshanowski.[8] Kryshanowski confirms the conclusion of previous workers that the living diphtheria bacillus does not secrete a preformed toxin. The toxin of current nomenclature is a hybrid product with environmental proteins. He finds that, *in vitro*, the non-toxic bacterial substance hybridizes with serum albumin to form a specific toxin. With certain serum globulins the resulting protein mongrel is a specific antitoxin. Intermediary serum bastards are physiologically inert. The language is mine, but the alleged facts are Kryshanowski's.

[5] *Ibid.*, 1926, 86: 1271.
[6] *Jour. Immunol.*, 1927, 13: 59.
[7] *Proc. Soc. Exper. Biol. and Med.*, 1929, 26: 525.
[8] *Centralbl. f. Bakt.*, 1929, 110: 1.

From Kryshanowski's aggressive albuminous bastards and loyal mongrel globulins there may in time be written a new immunological poem, worthy successor to the specific receptor allegory of current nomenclature.

XV

The hybridization metaphor offers logical and consistent explanations of many experimental and clinical facts inexplicable by present hypotheses. Torrey and Kahn's recent experimental findings, for example.[9] These investigators report that *B. welchii* filtrate, injected intravenously into rabbits, produces a slight anemia from which the rabbits rapidly recover and become immune. A much smaller dose injected into a single bone marrow is followed within eighteen hours by degeneration of all bone marrows of the body, with a resulting chronic, persistent, often fatal anemia. Evidently we are here dealing with a secondary autointoxication, some *B. welchii*-bone-marrow hybrid, a specific cytotoxin for marrow cells. Again, the language is mine.

XVI

If perchance the ancient hybridization theory is resurrected as the guiding immunological metaphor of the future, there are but few current immuno-clinical methods that will escape revision. According to current hypotheses, for example, more valuable therapeutic effects are logically expected from so-called hyperimmune antisera than from earlier sera with the same antigen. The marked specific protein-denaturizing acceleration with hypersensitive antibodies, contrasted with the denaturization inhibition with immune antibodies suggests that future clinicians may seek their therapeutic effects not with immune serum but with hypersensitive serum. Or with hypersensitive serum followed by but not mixed with immune serum.

The possibility that the dominant factors in acquired immunity are not test-tube "antibodies," but unknown substances revealed only by therapeutic tests, may in time harmonize clinical experience with serological data.

The heresy that the chemical nature of "antibodies" varies with the dosage of the injected antigen, with its concentration, portal of entry and subsequent topographical distribution, may in time lead to a renaissance of the discarded vaccine therapy of Wright, whose premature optimism led a generation of progressive physicians into such a morass of clinical failure.[10] Postulate for a moment a dozen chemically different antigen hybrids with local tissues, not forgetting preliminary hybrids in the culture medium. What new hope it breathes into this disheartening field!

Remember the newer biochemical evidence of tissue specificity. The demonstration that fixed tissue proteins are of a different immunological subspecificity from circulation proteins. Muscle hemoglobin sharply differentiated from blood hemoglobin, for example.[11] Liver proteins in the urine of patients suffering from hepatic lesions. Then reexamine the heroic illogic of Rosenow,[12] who in defiance of the dominant unitarian dogma of antibody formation, has insisted for two decades on an irrational elective localization of micro-organisms in tissues. Under the magic touch of the hybridization metaphor this ostracized heresy becomes the consistent logic of clinical expectation.

The hybridization metaphor also suggests the heterodox conception that asthma, hay-fever and other forms of protein hypersensitiveness are due to atypical, perverted or deficient protein denaturization. Subnormal denaturization coefficient. Hypofunction of some unknown protein-adopting insulin. Logic might no longer seek to throw asthmatics into prolonged sub-shock to carry them through a pollenization season, but might turn its sole attention to therapeutic aids to the underlying immunity hormone, that unstable hypersensitive protein bastards may be fully detotemized to dependable or stable tissue loyalty.

XVII

If you conceive the human body to be a mass of dead, inert material colloids, animated, coordinated and motivated by some great super-material vital purpose, this is all nonsense. But if you are attempting to explain biological organization on a purely material basis, you must seek the unit of vital phenomena in individual molecules, atoms and subatoms. To be consistent you must endow the antigen molecule with just the same unit life as that proudly reserved for your own colloids.

Breathe a metaphorical soul into the alien protein molecule.

As soon as you have accustomed yourself to this theo-biochemical heresy, the ancient food hybridization theory emerges from the discarded superstitions of dead paganisms. A prophetic metaphor. The next great immunochemical challenge to pioneers and prospectors in clinical truth.

As a challenge, rather than as demonstrated fact, I present it to you.

[9] *Amer. Jour. Path.*, 1929, 5: 117.
[10] *J. A. M. A.*, 1929, 92: 864.
[11] *Jour. Infect. Dis.*, 1928, 42: 31.
[12] "The Newer Knowledge of Bacteriology and Immunology," University of Chicago Press, 1928, Chap. xviii, p. 576.

OBITUARY

RECENT DEATHS

WORCESTER REED WARNER, founder with Mr. Ambrose Swasey, of Warner and Swasey, Cleveland, known among scientific men for their construction of astronomical telescopes, died at Eisenach, Germany, on June 25, in his eighty-fourth year. Mr. and Mrs. Warner sailed on May 8 to spend the summer in Europe.

M. R. OLDFIELD THOMAS, for many years assistant in charge of Mammalia at the British Museum, died on June 16, aged seventy-one years.

HENRI ANDOYER, professor of astronomy at the Sorbonne, Paris, died on June 12, aged sixty-six years.

THE deaths are also announced of Jules Cornet, professor of geology in the University of Ghent, and of Aldo Perroncito, professor of general pathology in the University of Pavia.

SCIENTIFIC EVENTS

THE CENTENARY OF JAMES SMITHSON

THE Smithsonian Institution commemorated on June 27 the one hundredth anniversary of the death of its founder, James Smithson, and prepared the following statement:

Smithson was an Englishman. He never set foot in this country. Yet he left his impress for good upon this nation and through it upon the world as no other citizen and resident of another country has ever done. For what Smithson bequeathed to the keeping of the United States was not merely a sum of money nor an institution. It was an idea; an idea fifty to a hundred years ahead of the times in which he secured it to America, but now the very root-idea of modern achievement. It was the idea of scientific research, of the importance of knowing. "No ignorance is probably without loss to man, no error without evil," wrote James Smithson, and he grubstaked this belief with his fortune. The Smithsonian Institution and all that it has meant to America and the world are the results.

We moderns are much closer to James Smithson than were his contemporaries and the honor that he lacked in his lifetime we can and should give him. The known details of his life are few and rather tragic. The natural son of Hugh Smithson, who later became the Duke of Northumberland, and of Elizabeth Keate Macie, who herself was descended from King Henry VII, he seems to have felt bitterly all his life the bar sinister on his name. He studied at Pembroke College, Oxford, and is reputed to have been the best chemist and mineralogist of his year. Certainly his devotion to science expressed itself at an early age, for at the age of twenty-two, the year after his M.A. from Oxford, he had already achieved enough to win him election to the Royal Society.

Smithson missed being a great scientist as a research worker, but he was a thorough and an indefatigable one. He made many chemical analyses of minerals, wrote several hundred papers, and did much field work in geology and mineralogy. His name lives in the mineral Smithsonite, the carbonate of zinc. But two qualities did render him a great man in science—one was the clarity of his thought and the other his tolerant vision. Nothing was too small nor too great for his consideration. With equal zeal he discussed the origin of the earth and improved oil lamps. Most important of all, he saw clearly and far ahead. He knew how much was to be done and saw the manner in which it would have to be done.

James Smithson never married; in his last years his health failed, and it must have been in the midst of unhappiness and with a sense of frustration that, away from his native land in Genoa, Italy, on June 27, 1829, he died. However, it is perhaps not too much to say that had he been the greatest scientist of his age he could not have served the world better than he did in leaving his fortune of roughly $540,000 "to the United States of America to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men."

In the hands of Joseph Henry, first secretary of the Smithsonian and the foremost American man of science of his day, Smithson's bequest became the inspiration of American science and even to a measurable extent of world science. It proclaimed actively the ideal of research, it provided funds at a time when there were no funds, it trained men, it seized fleeting opportunities, it gave direction to the most powerful single material force in modern life. Smithson's words and ideal have served as an inspiration to other men and institutions. "For the increase and diffusion of knowledge" has become the common expression of purpose for research establishments. The good that James Smithson did lives after him with a fruitfulness beyond measure.

RESEARCH IN COAL MINING AND METALLURGY AT THE CARNEGIE INSTITUTE OF TECHNOLOGY

A PROGRAM of eight research studies in coal mining and metallurgy will be carried on during the year 1929–30, under the joint auspices of the United States Bureau of Mines, the Carnegie Institute of Technology and Mining and Metallurgical Advisory Boards composed of mining and metallurgical engineers and executives. Eight college graduates have been ap-

pointed to research fellowships to make the investigations.

The research fellows, while carrying out their investigations, will be candidates for the degree of master of science to be awarded by the Carnegie Institute of Technology in June, 1930. As in the past, the reports of the studies will be published.

Appointees to research fellowships are Austin Gudmundsen, University of Utah; Bernard A. Jettner, College of Agriculture, Berlin, Germany; George C. Sprunk, Michigan State College; Donald A. Wallace, Iowa University; Boris N. Daniloff, Missouri School of Mines; John A. Heidish, Colgate University; Max W. Lightner, Pennsylvania State College, and Robert B. Meneilly, Grove City College.

Following is a list of the investigations that have been planned:

Fuel Chemistry

A continuation of the Study of the Effect of Fusain and Related Inerts on the Properties of Pittsburgh Coal, with particular Reference to Coking Properties.

A continuation of the Study of the Chemistry of Decay in Relation to Peat and Coal Formation.

A continuation of the Study of the Relation of Particle Size and Temperature to Rate of Burning.

A Study of the Agglutinating Properties of Coal.

Ferrous Metallurgy

Methods of Determining Non-metallic Inclusions.

Viscosity of Open-hearth Slags.

A Study of the Slag System MnO-Al_2O_3.

A Study of the Slag System MnO-Al_2O_3FeO.

THE MURRY AND LEONIE GUGGENHEIM FOUNDATION

MR. AND MRS. MURRY GUGGENHEIM, of New York City, have announced the formation of the Murry and Leonie Guggenheim Foundation for "the promotion, through charitable and benevolent activities, of the wellbeing of mankind throughout the world." At present the foundation will confine itself to the establishment of clinics for free dental relief work among the children of the five boroughs of New York City. The first clinic will be built in Manhattan at a cost of between $3,000,000 and $4,000,000. In time there will be at least one clinic in each borough.

In making this gift, Mr. Guggenheim said:

> Mrs. Guggenheim and I, having become thoroughly convinced of the great necessity for dental relief work, especially among the children of our great city, have decided to do what we can along this line. We are prepared to contribute a large sum of money for the construction, equipment and endowment of non-sectarian clinics for the treatment of children whose parents are not in a position to pay for this most important and essential work. Dr. S. S. Goldwater, former commissioner of health of New York City, has consented to formulate a suitable program. It is our intention to push the work vigorously, with the idea of placing the first unit in operation at the earliest date possible.

In addition to preventive and reparative work, including departments for straightening teeth, the clinics will train dental hygienists for work in public schools and industrial establishments. Efforts will be made to maintain a close affiliation with municipal health and school authorities. It is pointed out that the proposed clinics will benefit the dental profession by affording a new field for graduate study and training.

The charter members of the foundation are, besides Mr. and Mrs. Guggenheim, their son, Edmond A. Guggenheim; Carroll A. Wilson, lawyer; Hartley Robbins, Mr. Guggenheim's secretary, and Dr. S. S. Goldwater.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

HAROLD B. SMITH, professor of electrical engineering at the Worcester Polytechnic Institute, Worcester, Mass., and consulting engineer of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has been elected president of the American Institute of Electrical Engineers for the year beginning August 1, 1929, as announced at the annual meeting of the institute held at Swampscott, Massachusetts, on June 25, during the annual summer convention of the institute.

Three distinguished American engineers were elected honorary members. These were:

Herbert Hoover, most outstanding American engineer.

Charles F. Scott, engineer and inventor, head of the electrical engineering department of Yale University, past president of the institute.

Charles F. Brush, engineer and scientist, inventor of the arc lamp, Cleveland, Ohio, whose death occurred on June 15, at which time he was being balloted upon. The unanimous vote of the directors of the institute having been received, the directors voted on June 25 to record Dr. Brush's name in the list of honorary members.

Five other Americans and three representatives of foreign countries had previously been elected as honorary members of the institute. The Americans are John J. Carty, Thomas A. Edison, Michael I. Pupin, Ambrose Swasey and Elihu Thomson.

Officers elected were:

Vice-presidents, E. C. Stone, Pittsburgh, Pa.; W. S. Rodman, Charlottesville, Virginia; Herbert S. Evans, Boulder, Colo.; C. E. Fleager, San Francisco, Calif.; C. E. Sisson, Toronto, Ontario. *Directors*, J. E. Kearns, Chicago, Ill.; W. S. Lee, Charlotte, N. C.; C. E. Stephens, New York, N. Y. *National Treasurer*, George A. Hamilton, Elizabeth, N. J. (reelected).

These officers, together with the following hold-over officers, will constitute the board of directors for the next administrative year, beginning August 1:

R. F. Schuchardt (retiring president), Chicago, Illinois; Bancroft Gherardi, New York, N. Y.; E. B. Merriam, Schenectady, N. Y.; H. A. Kidder, New York, N. Y.; W. T. Ryan, Minneapolis, Minnesota; B. D. Hull, Dallas, Texas; G. E. Quinan, Seattle, Washington; I. E. Moultrop, Boston, Massachusetts; H. C. Don Carlos, Toronto, Ontario; F. J. Chesterman, Pittsburgh, Pennsylvania; F. C. Hanker, East Pittsburgh, Pennsylvania; E. B. Meyer, Newark, New Jersey; H. P. Liversidge, Philadelphia, Pennsylvania; J. Allen Johnson, Niagara Falls, N. Y.; A. M. MacCutcheon, Cleveland, Ohio; A. E. Bettis, Kansas City, Missouri.

The annual report of the board of directors, presented at the meeting, showed a total membership on April 30 of 18,133. In addition to three national conventions and three regional meetings, 1,400 meetings were held during the year by the local organizations in the principal cities and educational institutions in the United States and Canada.

SCIENTIFIC NOTES AND NEWS

THE Lister medal of the Royal College of Surgeons has been awarded to Dr. Harvey Cushing, Moseley professor of surgery in the Harvard Medical School and surgeon-in-chief of the Peter Bent Brigham Hospital. Dr. Cushing has undertaken to give an address in London in 1930.

THE final banquet of the convention of New York State Veterinarians, which has been in session at Cornell University, was devoted to paying tribute to Dr. Veranus A. Moore, retiring dean of the college of veterinary medicine. A testimonial scroll was presented on behalf of his many colleagues, former students and members of the veterinary profession by Professor W. A. Hammond, dean of the university faculty, and a tribute was paid in an address by Dr. Frank H. Miller, of New York City. On June 30 Dr. Moore completed thirty-three years of service to Cornell University, the state and the nation, twenty-one years of which he was dean of the college.

PRESIDENT HERBERT HOOVER, Surgeon-General H. S. Cumming, of the U. S. Public Health Service, and Dr. Frederick F. Russell, of the Rockefeller Foundation, have been elected honorary members of Delta Omega, the honorary public-health society. The gold key and the certificate of the society were presented to Mr. Hoover at the White House on June 18, by Lieutenant-Colonel Edward G. Huber and Dr. James A. Tobey, national president and secretary, respectively. Surgeon-General Cumming also participated in this ceremony. The only other honorary member of Delta Omega is Dr. Charles V. Chapin, of Providence, R. I., former president of the American Public Health Association.

THE degree of doctor of engineering was conferred on June 14 on Dr. Wm. H. Hobbs, head of the department of geology in the University of Michigan, by the Worcester Polytechnic Institute, where he delivered the commencement address on "Engineering and Polar Exploration."

AT the commencement exercises of Williams College the doctorate of science was conferred on Dr. Robert Allyn Budington, head of the department of zoology at Oberlin College.

DR. FRANK C. JORDAN, professor of astronomy in the University of Pittsburgh, received the honorary degree of doctor of science at the ninety-fourth annual commencement of his alma mater, Marietta College, on June 17.

AT the recent commencement exercises of Lehigh University the honorary degree of doctor of engineering was conferred on Robert Ridgway, of New York City, chief engineer of the New York City Transit Commission and past president of the American Society of Civil Engineers; the degree of doctor of science upon John Arthur Wilson, of A. F. Gallun and Sons Company, Milwaukee, in recognition of his work in the fields of colloidal and biochemistry and his contributions to the knowledge of leather technology, and the degree of doctor of laws upon Henry Chapman Mercer, of Doylestown, Pa., for his contributions to research in archeology and his inventions in the manufacture of art tiling.

DR. THOMAS MCCRAE, Philadelphia, has been elected president of the Association of American Physicians for the ensuing year. Dr. Rufus I. Cole, New York, has been elected vice-president, and Dr. James H. Means, Massachusetts General Hospital, Boston, secretary. The next annual meeting will be at Atlantic City on May 6 and 7, 1930.

PROFESSOR R. E. BUCHANAN, of the department of bacteriology at Iowa State College and dean of the graduate school, has been asked to serve as president of the section of bacteriology of the International Botanical Congress to be held in Cambridge, England, in August of 1930.

AT the annual general meeting of the Institute of Physics, London, held on May 28, the following officers were elected: *President,* Dr. W. H. Eccles;

Honorary Treasurer, Major C. E. S. Phillips; *Honorary Secretary,* Professor A. O. Rankine. Sir Ambrose Fleming, Sir James Jeans and Sir Oliver Lodge were elected honorary fellows of the institute.

PROFESSOR CHARLES J. CHAMBERLAIN, who joined the department of botany of the University of Chicago in 1897 as specialist in plant morphology and cytology, retired at the end of the academic year. Dr. George W. Myers, professor of the teaching of mathematics and astronomy in the school of education, also retires from active service.

PROFESSOR DOUGLAS JOHNSON, of Columbia University, has been appointed consultant to the board recently established by the chief of engineers of the U. S. Army to study sand movements and beach erosion along the Atlantic coast.

IN accordance with the recommendation of the Committee on the Study of Educational Problems in National Parks, Secretary Wilbur has appointed a committee to advise the director of national parks on matters of educational policy and development. Its personnel is: John C. Merriam, *chairman;* Wallace W. Atwood, Isaiah Bowman, Hermon C. Bumpus, Vernon Kellogg, Frank R. Oastler and Clark Wissler.

THE commission appointed by President Hoover to study proposed changes in the boundaries of Yellowstone National Park is announced as follows: Dr. E. E. Brownell, of San Francisco, who introduced antelope into the Grand Canyon; Dr. T. Gilbert Pearson, president of the National Association of Audubon Societies; Dr. Arthur Morgan, president of Antioch College, an engineer; C. H. Ramsdell, of Minneapolis, a landscape architect, and Arthur Ringland, an expert in forestry.

DR. A. G. MCCALL, chief of the soils investigations unit of the bureau of chemistry and soils, has been appointed chairman of the Federal-State Committee on Soil Erosion, appointed by Dr. A. F. Woods, director of scientific work of the department, to develop a national program for control of soil erosion and to set up erosion-prevention and moisture-conservation stations on eighteen erosion areas over the country, under an appropriation of $160,000 made by Congress for this purpose. The four other members of the committee are: S. H. McCrory, chief agricultural engineer of the Bureau of Public Roads; Dr. E. H. Clapp, assistant forester in charge of the research of the Forest Service; Dr. J. G. Lipman, dean of the New Jersey State College of Agriculture and director of the New Jersey Agricultural Experiment Station, and A. B. Conner, director of the Texas Agricultural Experiment Station.

DR. F. S. BRACKETT, of the University of California, has joined the Smithsonian Institution to undertake studies in the correlation between wavelengths and intensities of radiation and the growth of plants, and also fundamental investigations of the chemical relations of radiation such as may throw light upon the problem of so-called photosynthesis. Dr. O. R. Wulf, of the Fixed Nitrogen Research Laboratory, is also associated with the institution in the study of methods of measurement of ultra-violet rays useful for the prevention and cure of rickets in human beings and animals.

EIGHT men under direction of Dr. E. A. Birge, president emeritus of the University of Wisconsin, will spend the summer among the lakes of northeastern Wisconsin to study the contents of lakes, a task which Dr. Birge began thirty years ago.

PROFESSOR H. V. WILSON, head of the department of zoology of the University of North Carolina, will be absent on leave on the Kenan Foundation during the session 1929–30. During his absence Professor R. E. Coker will be acting head of the department; Dr. J. Manson Valentine, now at Western Reserve University, will be assistant professor of zoology, and Alan Mozley, now of the Johns Hopkins University, instructor in zoology. Dr. C. Dale Beers was recently promoted to become associate professor of zoology. Professor Wilson's address after September 1 will be The Zoological Station, Naples, Italy.

DR. RICHARD G. TYLER, professor of sanitary engineering at the Massachusetts Institute of Technology, who was recently appointed dean of the engineering school of the University of Washington, will spend the summer in Europe.

THE Colorado State Historical Society expects to start its archeological field work for this season about July 1. The work will be under the direction of Dr. Paul S. Martin, who will continue his excavations in the towers, kivas, refuse heaps and unit-type pueblos which abound on the mesas in the vicinity of Ackmen, Colorado.

PROFESSOR PANCHANAN MITRA, head of the department of anthropology and lecturer in ancient Indian history and culture at the University of Calcutta, is engaged in a study of Polynesian culture, with a view to tracing affinities of Indian culture. This study will be correlated with the work of Dr. E. S. Craighill Handy, ethnologist on the staff of Bishop Museum, who has been making a study of Indian culture. Professor Mitra, who is now completing his work in Hawaii, will, as a Bishop Museum fellow, extend his studies to the South Pacific, visiting Samoa, Fiji, Society Islands, Cook Islands and New Zealand.

DR. KARL MEYER, director of the University of California Hooper Foundation for Medical Research, left recently for Canada and Europe for a three-months' study of contemporary research in the Mediterranean and Malta fevers, and of public health problems in the canning industry. In Canada, he presided over a meeting of the American Association of Medical Milk Commissions, held in Montreal, on June 24 and 25.

DR. JEWELL B. KNIGHT, of Harvard University, formerly at the Agricultural College of Poona, India, sailed for Nicaragua on June 13 as a representative of the Tropical Plant Research Foundation. Dr. Knight will remain for several months to prepare a plan for an agricultural school and experiment station which the government of Nicaragua proposes to establish.

A CONTRIBUTION of $1,000 has been received by Stanford University Medical School to start a memorial in honor of the late Dr. Richard G. Brodrick, superintendent of Stanford University hospitals and formerly president of the American Hospital Association. The income will be used for clinic free beds.

THE *British Medical Journal* states that the contributors to a fund to commemorate the late Sir David Ferrier and his pioneer work upon the functions of the brain have requested the council of the Royal Society to accept the sum of £1,000 in trust for the institution of a David Ferrier Lecture. The council, in accepting the trust, decided that the lecture should be given triennially on "a subject relating to the advancement of natural knowledge of the structure and function of the nervous system." The first David Ferrier Lecture was delivered by Sir Charles Sherrington, O.M., G. B. E., on June 20, at the rooms of the Royal Society, Burlington House, at 4: 30 P. M. The title of the lecture was "Some Functional Problems attaching to Convergence."

A BRONZE portrait plaque of the late Sir William Schlich was recently unveiled in the School of Forestry at Oxford by the vice-chancellor, Dr. F. W. Pember. Sir William Schlich was at one time inspector-general of forests to the Government of India, and afterwards professor of forestry at Cooper's Hill and later at the University of Oxford. In addition to the bronze plaque, the committee formed in 1926 to raise a memorial fund has asked and received permission from the forestry commissioners to set apart an area of forest to be named the Schlich Forest, situated if possible within easy reach of Oxford, which will be available for experimental work. Subscriptions amounting to about £1,700 have already been received from various parts of the British Empire and the United States. The interest on the sum collected will be paid each year in rotation to different parts of the Empire and to the United States, and devoted to some purpose calculated to further the cause of forestry.

THE United States Civil Service Commission announces the following examinations for associate and assistant civil engineer, at salaries from $2,600 to $3,700. Applications must be on file not later than July 24. The examinations are to fill vacancies in the Engineer Department at Large, War Department, throughout the United States and in positions requiring similar qualifications. Competitors will not be required to report for examination at any place, but will be rated on their education, experience and fitness. An examination will be held on July 23 for the position of junior mathematician in the U. S. Coast and Geodetic Survey at a salary of $2,000.

THE Botanical Society of America met at Hanover, N. H., on June 25, for the first of two summer meetings. The delegates who were the guests of Dartmouth College planned field trips and discussion of botanical problems under the leadership of Harvard, Cornell, Yale and University of Toronto professors. The second meeting will be held at the University of Wyoming in August.

AN Associated Press dispatch reports that nearly two hundred scientific men sailed from Tilbury, England, on June 27, for South Africa on the *Llandovery Castle* for the annual meeting of the British Association scheduled in Cape Town, Johannesburg and Pretoria during July and August. The contingent was an advance guard of the 550 members of the association making the trip, the remainder traveling on other steamers on various dates. South Africa is allowing films and lantern slides for lectures to be imported free of duty and the shipping companies have placed projection lanterns on board so that lectures can be given *en route*.

THE London *Times* reports that Messrs. Henry Sotheran, Limited, of Piccadilly and the Strand, are offering for sale a large number of books, many of which, if not all, at one time formed part of the library of Sir Isaac Newton. The story of the "find" forms one of the romances of bookselling. The existence of Newton's library was quite unknown until recent times. In 1920 a sale of furniture took place in a country house, which contained about 30 lots of books, some of which were described "with the autograph of Isaac Newton." Some of these books came into the possession of Messrs. Sotheran, and were catalogued as such in their science catalogues. Quite recently the owner of these books discovered a number of other volumes that had formed part of this library, and on examination they were found to con-

stitute the larger and more important of Newton's library, and these books are now offered for sale *en bloc*. The collection consists altogether of 858 volumes, nearly all in contemporary binding. Eighty-three of the books show actual marks of Newton's handwriting, and 20 have his autograph signature. Four of these are of special interest, as they bear the date of 1661, the year in which Newton entered Trinity College, Cambridge. The most important items of the collection are the first and second editions of the "Principia," full of corrections, cancellations and additions, all in Newton's handwriting. There is also the corrected copy of the first edition of the "Opticks," 1704, with an important note by Newton on the limits of telescopic performance. There are also a large number of books and tracts on mathematics, navigation and political economy, and altogether the collection is one of remarkable scientific interest.

DURING the centenary celebrations of the Cockerill Works at Seraing, Belgium, the King made an appeal for the creation of a National Fund for Scientific Research. In less than a year a sum of 112,000,000 francs was subscribed by 1,200 contributors, and the fund began its work. The results so far achieved have now been made public. Grants have been made to enable thirty young doctors or engineers to devote themselves to scientific research under the aegis of their employers and 78 subsidies were allocated to other research students.

A COMPLETE modern hospital plant, valued at $100,000, has been offered as a free gift to the town of Marblehead, Massachusetts, by Dr. Joel E. Goldthwait, of Boston, and his brother William J. Goldthwait, of Marblehead.

A LIFE-SIZE restoration of a Neanderthal family has been placed on exhibition in Ernest R. Graham Hall of Historical Geology at the Field Museum of Natural History, Chicago. The group consists of the hunter and head of the family, a mother and baby, a boy of about twelve years and an old woman, represented as engaged in occupations typical of their time and stage of development. For background the group has a reproduction of a cave at Le Moustier, France, and a scene representing the near-by country. The group is a gift to the museum from Ernest R. Graham, one of the institution's trustees. It is the work of Frederick Blaschke, sculptor, of Cold Spring, N. Y., who was a member of the recent Marshall Field, Jr., Archeological Expedition to Western Europe, led by Henry Field, assistant curator of physical anthropology at the museum. Through the cooperation of leading anthropologists of England and France, measurements, casts and data were obtained from Neanderthal skulls and skeletons for use in making the reconstructions. Among those who assisted the members of the expedition were Professor Sir Arthur Keith, president of the Royal College of Surgeons, London; Professor G. Elliott-Smith, of University College, London; Abbé Henri Breuil and Professor Marcellin Boule, of Paris.

THE *Journal* of the American Medical Association writes that next September Italian students of genetics and eugenics will meet in Rome under the chairmanship of Professor Corrado Ricci. Foreign students of eugenics, who, on the occasion of the annual meeting of the International Federation of Eugenics, will be in Rome on that date, will be invited to attend this meeting. Among the speakers, Professor Artom will speak on genetic constitution and the changes that result from the union of different races; Professor Baglioni on somatic and genetic functions; Professor Enriquez on environment and heredity according to the most recent investigations; Professor Pestalozza on sterilization, and Professor Quagliarello, of Naples, on the influence of nutrition on the characteristics of the offspring. Professor Foà, physiologist of Milan, will illustrate the topic of biologic factors of birth control.

SIGMA DELTA EPSILON (Scientific Fraternity for Graduate Women) established a new chapter at Northwestern University on May 28. This organization, which meets a long-felt need by promoting closer association among women doing scientific work, has made rapid growth since its establishment at Cornell University in 1921. Since that date chapters have been established at the University of Wisconsin, the University of Illinois, the University of Missouri, the Iowa State College, Brown University, the University of Chicago, the Ohio State University, the University of Nebraska and in New York City. Dr. Stella M. Hague, of the University of Illinois, is national president of this organization, and Dr. Helen Jean Brown, of the Ohio State University, national secretary.

THE Mawson Antarctic expedition ship, *The Discovery*, which has been laid up in the South India Dock for some time, has, according to the London *Times*, now been moved into the Blackwall Dry Dock, where she will be fitted with echo-sounding gear for measuring the depths of the ocean. It is expected that she will leave the dry dock early in July and will then be berthed in the East India Dock, where she will take on board stores and equipment for the expedition. *The Discovery* is due to sail from London on August 1, under the command of Captain J. K. Davis, Director of Investigation in the Marine Department of the Commonwealth Government, on a two years' expedition of research. She will have a

crew of 26, and a number of the scientific staff will sail with her from the Thames. The vessel will call at Cardiff, where her bunkers will be filled with patent fuel. She will then proceed to Cape Town and will take on board Sir Douglas Mawson, the leader of the expedition, and the remaining members of the scientific staff. Captain Frank Hurley has been appointed official photographer to the expedition. Mr. W. J. Griggs, who has been in the service of the P. and O. Company, has been appointed chief engineer of *The Discovery*. Captain Hurley accompanied the Antarctic expedition of 1911–14 as official photographer, and afterwards acted in a similar capacity with the *Endurance* expedition, under Sir Ernest Shackleton, in 1914–17. In the war, Captain Hurley served as official photographer to the Australian forces. He carried out exploratory work in New Guinea and recently made a flight from Australia to Europe.

UNIVERSITY AND EDUCATIONAL NOTES

THE University of Pennsylvania has received a gift of $500,000 from Edward B. Robinette, Philadelphia banker and trustee of the university, for the establishment of three professorships. The gift was the third made by Mr. Robinette during the year. The first was of $250,000 to the Robinette Foundation and later an additional $250,000 was given for any use needed.

BY the will of James B. Wilbur, Chicago banker and a summer resident of Manchester, Vermont, a trust fund of between $2,000,000 and $3,000,000 has been left to the University of Vermont, subject to the condition that the university limit its number of students.

TWO Paul Williams research fellowships of $1,000 have been established at Purdue University, one for the X-ray laboratory and one for the optical laboratory.

DR. JOHN FARQUHAR FULLER, JR., of St. Paul, Minnesota, who in 1928 received a three-year appointment as fellow of Magdalen College, has been appointed head of the department of physiology at Yale University. Dr. Farquhar will attend the Thirteenth International Physiological Congress in Boston in August and will then return to Oxford. He will begin his work at Yale on July 1, 1930.

APPOINTMENTS to professorships in the school of mines of Columbia University are of Dr. Thomas Thornton Read, in mining and metallurgy, and of Dr. Eric Randolph Jette, now associate professor of chemistry in New York University.

DR. K. LARK-HOROVITZ, professor of physics at Purdue University, has been appointed director of the laboratory of physics. Dr. G. E. Reed has been appointed assistant professor.

DISCUSSION

A MECHANICAL PARALLEL TO THE CONDITIONED REFLEX

IT is common knowledge that when a person eats, his "mouth waters." It is well known that this mouth watering is apt to occur also when one merely catches sight of delicious food. The first reaction is an unconditioned (native, unlearned) reflex; the second is a conditioned (acquired) reflex. In the first reaction the food substance stimulates the sense organs in the mouth which, in turn, evokes a salivary reflex established before birth; in the second reaction the sight of food has been substituted for the contact of the food with the mouth. Nevertheless, in both cases substantially the same reaction follows.

It is believed by increasing numbers of students of human and other mammalian behavior that the conditioned reflex, with its power of substituting one stimulus for another, is the basic mechanism not only of ordinary habits but of the entire mental life. For some years this view has been vigorously advanced in this country by the behavioristic psychologists. In Russia, where the movement originated, its activity has been characteristically experimental in nature. Thanks largely to the labor of the Russian reflexologists during the last quarter century there now exists a very substantial body of knowledge tending strongly to support this view.[1] As a result, psychologists more and more are looking to the conditioned reflex as an explanatory principle by means of which to understand the more complex forms of behavior and as a practical means of more effectively molding human nature in the education process. Physiologists, facing in the opposite direction, are stimulated to explore the still more basic physical and chemical processes upon which the conditioned reflex itself depends.

The belief of the reflexologists and the behaviorists that the mental life is essentially a function of various complex organizations of conditioned reflexes offers a challenge to the attempt at a synthetic verification. Logically, if it were possible to construct non-living

[1] The most significant summary of the Russian experimental results now available to English readers is the recent translation of I. P. Pavlov's great work, "Conditioned Reflexes." Oxford University Press, 1927.

devices—perhaps even of inorganic materials—which would perform the essential functions of the conditioned reflex, we should be able to organize these units into systems which would show true trial-and-error learning with intelligent selection and the elimination of errors, as well as other behavior ordinarily classed as psychic. Thus emerges in a perfectly natural manner a direct implication of the mechanistic tendency of modern psychology. Learning and thought are here conceived as by no means necessarily a function of living protoplasm any more than is aerial locomotion.

In casting about for principles upon which to base the construction of a mechanism which would parallel the essential behavior of the conditioned reflex, the principle of endosmosis was at first considered. This was rejected both because its effects were too slow in taking place and because they were too slight in amount. An early model was constructed on the principle of potential changes. This gave some promise but was found to yield only two or three of the characteristic types of reaction required.

The mechanism which has given the best results is a combination of polarizable cells and mercury-toluene regulators, which are sensitive to temperature changes. Ordinary electric switches serve as "receptors"; a flashlight bulb is the responding "organ," analogous to the salivary gland of the experimental animal. By a manipulation of the switches in a manner strictly analogous to the presentation of stimuli in Pavlov's conditioned reflex experiments, phenomena, paralleling fairly accurately a considerable number of the properties of the conditioned reflex, are obtained. Thus far the following conditioned-reflex phenomena have been duplicated:

(1) The simple substitution of a stimulus.
(2) Complex redintegration.
(3) Irradiation of excitation.
(4) Weakening through lapse of time (forgetting).
(5) External inhibition.
(6) Experimental extinction.
(7) Reinforcement.
(8) Spontaneous recovery after experimental extinction.
(9) Differentiation.
(10) Differential extinction.
(11) Conditioned inhibition.
(12) The acquisition of conditioned reflexes only when the conditioned stimulus precedes the unconditioned stimulus.

It is hoped that further research will result in a model which will also show the phenomena of delayed reflexes, trace reflexes, responsiveness to temporal stimulus patterns and the various other complex behavior patterns characteristic of the conditioned reflexes as observed in mammals. A complete technical description of the apparatus is being prepared for publication.

The germinal idea of the present project originated with the first author; the design and construction of the mechanism is due entirely to the second.

CLARK L. HULL
H. D. BAERNSTEIN

UNIVERSITY OF WISCONSIN

CHANGES IN THE RATE OF RESPIRATION OF THE FRUITS OF THE CULTIVATED BLUEBERRY DURING RIPENING

IN connection with work on the diseases of blueberries in New Jersey during 1926, a study was made of the rate of carbon dioxide production at three stages of ripeness in ten varieties of blueberries, mostly cultivated varieties of *Vaccinium corymbosum* L. The tests extended over a period of more than a month, the different varieties maintaining the same relative position whether picked early or late.

The most striking feature brought out by these experiments is that the greatest production of carbon dioxide occurs during the period of color development, that is, from the first pink coloration to the red-ripe stage. After the stage of full red coloration, the rate of carbon dioxide production decreases rapidly as ripening proceeds to the blue stage at which the fruit is picked. These changes in the rate of carbon dioxide production were shown clearly by the selection of three stages of ripeness—green, full size, showing no pink color; pink to red-ripe, and blue-ripe. A change in the rate of carbon dioxide production such as that herein described represents a condition which has not been previously reported for any fruit, nor has it been found in any of the other small fruits so far studied by the writer.

The variety Rubel produced carbon dioxide more slowly than any of the other varieties studied, which may have some significance in view of the fact that Rubel has shown the best keeping quality of any of the varieties which were tested. It is planned to repeat these studies with a wider range of varieties, particularly those of the recently developed varieties which have shown unusual keeping quality.

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AN INTERNATIONAL LIST OF GENERA OF VASCULAR PLANTS

FOR some years botanic gardens have corresponded in regard to possible simplification of the mutual exchange of seeds, including greater uniformity of arrangement and nomenclature for seed lists. It appears that the great works, the "Index Kewensis"

and the "Natürliche Pflanzenfamilien," although admittedly out of date in many particulars, are still most widely used as general authorities. The number of genera of seed-bearing plants according to the former is about 8,300; according to the latter, about 9,700. Nearly 8,000 names are common to these two works, thus constituting a substantial beginning toward a very widely acceptable list of generic names, that is, such as have been used for more than fifty years.

Seeking to follow the general suggestions received from other botanical institutions, the Brooklyn Botanic Garden is listing these 8,000 genera by families. Under each are added the names as to which there are nomenclatural or taxonomic differences. The usage or preference of a number of institutions as to families and the most frequently used genera are included. The whole will make a pamphlet of hardly forty pages: thus corrections can readily be made in the direction of the needed international list of genera.

It is expected that many disputed points as to nomenclature will be decided at the Cambridge congress in 1930. But taxonomic differences are many times more numerous than nomenclatural ones. How can taxonomic usage be made more nearly uniform?

We believe that scientific and practical requirements may be most nearly harmonized if a list of genera, with the strength of a recommendation, be added as an appendix to the International Rules of Nomenclature, somewhat as follows:

Article 20. Recommendation I^{ter}. For botanic gardens, for horticultural purposes, for the international exchange of seeds and for other practical uses, a complete list of families and genera of vascular plants is provided, as of 1931. Nomenclatural matters of this list are decided by the International Committee of Nomenclature. Taxonomic matters are decided by a group of institutions designated by the congress. Revised lists will appear at intervals until 1940, and thereafter every ten years. This list is not intended to interfere with the nomenclature of taxonomic research publications.

ALFRED GUNDERSEN

BROOKLYN BOTANIC GARDEN

GREGOR MENDEL

GREGOR MENDEL was born in Neu-Titschein, Czecho-Slovakia. Certain men of science in Czecho-Slovakia, particularly in his native province, are seeking to establish a monument to him. The total amount needed is $3,000 and of this half has been raised. The committee hopes that geneticists in the United States and philanthropists who may be interested thus to participate in honoring Mendel would contribute about $1,000 to the deficit. The treasurer of the fund is Franz H. Nitsch, official director of the Neu-Titschein Savings Bank. Funds may be sent to him directly or, if preferred, to the undersigned, who has been asked to collect funds in the United States.

It has seemed unnecessary to add anything concerning the great, well known and deeply appreciated part that Mendel has played in the advancement of biological science.

CHAS. B. DAVENPORT

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

ANOTHER SYNTHETIC RESIN USEFUL IN MICROSCOPY

AN account was published in SCIENCE[1] in 1927 in which was given some of the properties of a synthetic resin which appeared to be useful in certain classes of microscopic mounting. This substance was derived from aniline and possessed a strong yellow color. The only suitable solvent known was aniline, and because of the comparatively high temperature required to evaporate the liquid in a reasonable time the resin appears to be unsuited to much work in biology, although these properties in no way detract from its usefulness in the mounting of fossil diatoms for which it was originally made and recommended. This resin was listed as A. F. S. in my protracted series of experiments on mounting media.

[1] Hanna, SCIENCE, 65, 1927, No. 1672, pp. 41–42; No. 1693, pp. 575–576.

It now seems fitting to announce another synthetic product having very different properties. This is a derivative of the simple hydrocarbon, naphthalene; it is soluble in xylol, benzol, toluol, and many other organic solvents, but not in water or alcohol. No color can be detected in slides mounted with this material, and in large bulk it has but a faint straw color—less than in the same quantity of Canada balsam. The resin has been noted as *hyrax*.

Test slides made with this resin have not changed in color or other characters in eighteen months' exposure, and nothing has appeared to indicate that they are not permanent. The material stands an exceedingly high temperature without decomposing or discoloring, and the ordinary oven treatment to which balsam mounts are subjected quickly removes the solvent because of the absence of difficultly volatile substances such as the turpenes in balsam.

By far the most valuable property of the resin from the standpoint of the critical microscopist is the very high refractive index. When dried on the slide this is between 1.70 and 1.80, a figure far higher than balsam, styrax or other common mounting media. Since fine structure becomes more and more visible the higher the refractive index of the material in which the object is mounted it is obvious that hyrax will show details that are completely invisible in a balsam mount. This property makes the resin particularly valuable in the study of diatoms. In this respect it is almost equal to A. F. S., while its pleasant odor, lack of color and other desirable properties make it more satisfactory for general use. There does not appear to be any chemical reaction with such common stains as have been tested; no fading has been detected thus far.

These experiments are being continued, and while hyrax may not be the best synthetic resin which will eventually be developed it certainly is the most valuable for certain classes of work which has thus far been found. The early batches of the material possessed a definite straw color but by careful chemical manipulation Messrs. L. A. Penn and Paul Ruedrich, who are associated with me in the experiments, have succeeded in producing it practically without color.

G. DALLAS HANNA
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SPECIAL ARTICLES

ON THE RELATION OF POTASSIUM TO IRON IN THE COMBUSTION OF CIGAR-LEAF TOBACCO[1]

IT has long been recognized that potassium may act as a catalyst in the combustion of cigar-leaf tobacco, and that its efficiency in this respect is largely determined by the form in which it is found in the leaf. These points have never been questioned seriously, but opinions have differed concerning the exact mechanism involved in this form of catalysis.

In our studies on the burning qualities of Pennsylvania cigar-leaf tobacco, we have substantiated the claims of others, namely, that ready combustion is usually, but not always, associated with potassium in organic rather than in inorganic forms of combination. Moreover, we found that if the ash of a cigar was rubbed into the surface of an ash-free cellulose filter-paper, the latter could be made to burn with a glow, instead of a flame, and that the ash from a good burning cigar was more efficient in this respect than the ash from a cigar of inferior burning qualities. This suggested a modification of Garner's method[2] for a study of the effect of individual ash constituents on the combustion of organic materials, apart from those of the cigar-leaf, inasmuch as both insoluble and soluble ash constituents could be used advantageously.

As a result of these experiments it was found that a number of ash constituents and many of the organic compounds of the leaf imparted glowing qualities to the filter-paper. Of these, however, potassium carbonate appeared to be more efficient than any of the compounds studied, although its use usually resulted in the production of a dark ash. It is our opinion that the catalytic action of potassium carbonate on the burning of filter-paper is due to the fact that the potassium ion forms auto-oxidizable compounds with cellulose derivatives, and that the carbonate itself aids in the dispersion of carbon particles, thus increasing the total surface for combustion. That moisture must play a part in the dispersion of carbon was indicated by the fact that a dry mixture of carbon and potassium carbonate did not burn more readily than carbon when used alone. We conclude, therefore, that what holds true for pure cellulose holds true also for leaf tissue. In the latter, however, a greater dispersion of other materials present may likewise take place, materials which may have a catalytic action as well. Among these may be mentioned iron oxides. The presence of a mere trace of these compounds aids in the combustion of dry carbon.

Potassium carbonate, mixed with iron oxides which were obtained by the combustion of organic iron salts, when applied to filter-paper, was found to have a more beneficial effect on the glowing capacity and thoroughness of combustion than when either material was used alone. This observation led us to anticipate a rather close relationship from the standpoint of combustion between potassium and iron as they occur within the leaf. Tests on fermented samples of tobacco failed to show the presence of either the ferric or ferrous iron. A test showing the presence of complex ions of iron, on the other hand, was readily obtained. We have reason to assume, therefore, that the iron must be present in combination with salts of hydroxy acids or related compounds, which normally occur in the leaf. Experiments on the effect of these complex salts on the combustion of filter-paper showed that potassium-iron-citrate, for example,

[1] Published by permission of the director of the Pennsylvania Agricultural Experiment Station as Technical Paper No. 474.

This investigation was conducted in cooperation with Dr. W. W. Garner, of the U. S. Department of Agriculture, Bureau of Plant Industry, Office of Tobacco and Plant Nutrition, and Professor F. D. Gardner, of the department of agronomy of the Pennsylvania State College.

[2] U. S. D. A. Bur. Plant Ind. Bul. 105.

was far more efficient as a catalytic material than ammonium-iron-citrate.

The tests on filter-paper were followed by tests on pure sucrose, used alone or with various other materials, and heated to high temperatures in porcelain dishes. It was found that when sugar, alone, was used, a large increase in volume was obtained, followed by a less rapid loss of water, and fair combustion was apparent until all the water was eliminated. On the other hand, when equal parts of potassium-iron-citrate were used, a less increase in volume was obtained, followed by a slow loss of water. In this instance, however, ready combustion was effected. If the flame was removed before combustion was complete, the mass was found to glow for a long period of time. On complete combustion, a coherent ash remained, containing iron oxides, uniformly distributed and in a very finely divided condition. A somewhat similar result could be obtained by using the ash of a good burning cigar, but not with ammonium-iron-citrate or similar compounds.

The iron remaining behind was found to possess magnetic properties, even when the temperature used exceeded that of a burning cigar. Tests on cigar ash yielded magnetic iron, but only where combustion was incomplete, no test being obtained where carbon was absent. It was thought that the force of attraction between the oxides and certain of the ash constituents was great enough to overcome the magnetic force, because magnetic iron added to an ash failed to respond to a magnetic field. On the other hand, where the iron was not well distributed, enough of the iron oxides became localized in quantities sufficient to overcome the attractive force of the ash particles.

It is suggested, therefore, that good combustion of cigar-leaf tobacco is associated with potassium compounds which give rise to potassium carbonate during combustion, and that the presence of such compounds may serve to intensify the catalytic effects of iron on this process.

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CARBON DISULFIDE EMULSION FOR THE CONTROL OF A NEMATODE

CARBON DISULFIDE in the un-emulsified state was one of the earlier materials tested in the search for suitable means of controlling the root-knot nematode *Heterodera radicicola* Greef. Several workers[1] reported that the chemical showed some merit for this purpose. Zimmerley and Spencer[2] found it ineffective under greenhouse conditions. Objections to the use of CS_2, such as inflammability, disagreeable and persistent odor, cost and doubtful value as a nemacide, appear to be sufficient explanation for investigators turning to other chemicals and control methods.

We have recently treated nematode-infested soil in a greenhouse with an emulsion of carbon disulfide[3] similar to that developed to control larvae of the Japanese beetle *Popillia japonica* Newman and Asiatic beetle *Anomala orientalis* Waterhouse in lawns. The results of these preliminary tests are encouraging. An emulsion containing approximately 0.7 per cent. *actual* CS_2 has freed infested soil of nematodes under conditions tested.

Applications were made at the rate of one gallon of the diluted emulsion to each cubic foot of soil (greatest depth dimension, eight inches). Soil in pots and in a standard greenhouse bench was included in the experiments, maintaining, of course, adequate check pots and plats. It remains for future investigation to determine: the minimum dosage for a given unit of soil for commercial control; the range of efficiency for such variables as type and condition of soil and the stage and location of the nematode; and finally, from the cost of the treatment, whether or not it has a field of usefulness.

In large commercial greenhouses the soil in the ground or bottom beds is commonly disinfested with steam. The smaller houses are usually not supplied with the necessary heating equipment for steam sterilization. Even in the larger houses it is difficult to treat the benches with steam. Hot water has also been successfully used to control nematodes, but the same factors limiting the use of steam apply to this method and in addition it is more laborious and expensive. It is not feasible for use on bench soil. Carbon disulfide emulsion, if it should eventually fulfil the qualifications of a nemacide, might prove useful in small greenhouses and in treating benches where steam and hot water disinfestation is impractical in large houses. Its cost will limit the use of the emulsion outdoors but it may be valuable for treating seed beds and small areas of ground intended for valuable plants.[4]

P. J. CHAPMAN
M. M. PARKER

VIRGINIA TRUCK EXPERIMENT STATION

[1] E. A. Bessey, Bureau of Plant Industry Bul. 217. 1911. J. A. McClintock, Michigan Tech. Bul. 201. 1915. J. R. Watson, Fla. Bul. 200: 201. 1919. And others.

[2] H. H. Zimmerley and H. Spencer, Virginia Truck Expt. Sta. Bul. 43: 272. 1923.

[3] Supplied by I. P. Thomas and Son Co., Philadelphia, Penna.

[4] The writers call attention to the appearance of a paper by Schaffnit and Weber (*Anz. für Schädlingskunde*, 5: 19) under date of February 15, 1929, in which similar experiments are reported. The present paper was accepted for publication in SCIENCE on February 4, 1929, and is based on work done in the fall of 1928.